



NAVAL
POSTGRADUATE
SCHOOL

The Modeling, Virtual Environments, and Simulation (MOVES) Curriculum

**Revision 5.0
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The MOVES Executive Academic Committee

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MOVES (399) CORE MATRIX – ALL STUDENTS

Refresher (Summer)	CSR-101 (2-1) Refresher for Lab Systems	MA-1042 (2-0) Matrix Algebra [†]	MA-1113 (5-2) Single Variable Calculus ²	MA-1025 (4-0) Intro to Finite Math	
Quarter 1 (Fall)	CS-2900 (4-2) Introduction to Objects & Programming	CS-3010 (4-2) Computer Systems Principles	OS-3111 (4-1) Probability & Statistics ^{1,3}	OA-3401 (3-1) Human Factors in System Design	MV-4921 (2-0) Introduction to MOVES [†]
Quarter 2 (Winter)	CS-3901 (4-2) Intro to Data Structures & Intermediate Programming	MV-3204 (3-2) Computer Graphics Modeling Using X3D/VRML	OS-3112 (4-1) Statistics & Data Analysis ^{1,3}	MV-4002 (4-1) Simulation and Training ⁴	MV-4922 (2-0) Introduction to Virtual Environment Technology [†]
Quarter 3 (Spring)	CS-3771 (4-2) C++ as a Second Language	CS-3502 (4-2) Computer Comms & Networks	OS-3113 (4-1) Advanced Data Analysis ^{1,3}	OS-3307 (4-0) Stochastic Models & Military Applications ^{1,4}	MV-4923 (2-0) Current Research in MOVES [†]
Quarter 4 (Summer)	MV-3202 (3-2) Computer Graphics Programming	CS-3310 (4-1) Artificial Intelligence	OA-3302 (4-0) System Simulation I	OA/MV4655 (4-0) Intro to Combat Modeling	MV-4924 (2-0) Research Seminar in MOVES [†]

Key: Computer Science Core Requirements --- MOVES Core Requirements ---

OR Core Requirements --- Refresher Courses --- JPME Requirements --- SIWC Requirements

‡ Available on-line. See <http://online.nps.navy.mil>

† Spring entrants will take MV4923 (Q1), MV4924 (Q2), MV4921 (Q3), MV4922 (Q4). For Spring entrants, Refresher is in Winter, Q1 in Spring, etc.

Notes:

1. Denotes shared with Human Systems Integration curriculum.
2. For students entering with a recent calculus background, MA1115 will be taken in the refresher.
3. For students entering with a recent calculus background, OA3101, OA3102, OA3103, and OA3301 are taken for the probability, statistics, and stochastic models sequence.
4. Formerly, MV4002 Training in Virtual Environments

New Courses:

OS3307 Stochastic Models & Military Applications (M. Kress)

MV4460 Management of M&S Development (T. Cioppa)

OA/MV4100 Cognitive Engineering (C. Darken)

MOVES (399) 2nd YEAR CORE MATRIX – ALL STUDENTS

Quarter 5 (Fall)	Block Requirement	Block Requirement	Block Requirement	Block Requirement	MV-4924 (2-0) Research Seminar in MOVES
Quarter 6 (Winter)	Block Requirement	Block Requirement	Block Requirement	Block Requirement	MV-4924 (2-0) Research Seminar in MOVES
Quarter 7 (Spring)	MV-0810 Thesis Research	Block Requirement	Block Requirement	Block Requirement	OA-4658 (2-0) Survey of Combat Models ⁶
Quarter 8 (Summer)	MV-0810 Thesis Research	MV-0810 Thesis Research	MV-4460 (4-0) Management of M&S Development ⁵	Block Requirement	OA-4658 (2-0) Survey of Combat Models ⁶

Key: Computer Science Core Requirements --- MOVES Core Requirements ---
 OR Core Requirements --- Refresher Courses --- JPME Requirements --- SIWC Requirements

Block requirements are filled in by choosing THREE blocks from the list.

5. MV4460 will be offered only once per year. Spring entrants take MV4460 in Q6.
6. Concurrently with OA4658, students will also register for and take the MV4924 seminar

MOVES (399) 2nd YEAR SIWCC – ALL NAVY STUDENTS

Quarter 5 (Fall)	Block Requirement	Block Requirement	Block Requirement	CC-3000 (4-0) Introduction to JC4I Systems in DOD	MV-4924 (2-0) Research Seminar in MOVES
Quarter 6 (Winter)	Block Requirement	Block Requirement	Block Requirement	IW-3101 (4-1) Principles of Information Operations	MV-4924 (2-0) Research Seminar in MOVES
Quarter 7 (Spring)	MV-0810 Thesis Research	Block Requirement	Block Requirement	SS-3011 (3-0) Space Technology & Applications	OA-4658 (2-0) Survey of Combat Models ⁶
Quarter 8 (Summer)	MV-0810 Thesis Research	MV-0810 Thesis Research	MV-4460 (4-0) Management of M&S Development ⁵	NW-3230 (4-2) Strategy and Policy	OA-4658 (2-0) Survey of Combat Models ⁶

Key: Computer Science Core Requirements --- MOVES Core Requirements ---
OR Core Requirements --- Refresher Courses --- JPME Requirements --- SIWC Requirements

Block requirements are filled in by choosing THREE blocks from the list.

5. MV4460 will be offered only once per year. Spring entrants take MV4460 in Q6.
6. Concurrently with OA4658, students will also register for and take the MV4924 seminar

MOVES (399) 2nd YEAR JPME/SIWC – ALL NAVY URL STUDENTS

Quarter 5 (Fall)	Block Requirement	Block Requirement	CC-3000 (4-0) Introduction to JC4I Systems in DOD	NW-3230 (4-2) Strategy and Policy	MV-4924 (2-0) Research Seminar in MOVES
Quarter 6 (Winter)	Block Requirement	Block Requirement	IW-3101 (4-1) Principles of Information Operations	NW-3275 (3-0) Joint Maritime Operations Part 1	MV-4924 (2-0) Research Seminar in MOVES
Quarter 7 (Spring)	MV-0810 Thesis Research	Block Requirement	SS-3011 (3-0) Space Technology & Applications	NW-3276 (3-0) Joint Maritime Operations Part 2	OA-4658 (2-0) Survey of Combat Models ⁶
Quarter 8 (Summer)	MV-0810 Thesis Research	MV-0810 Thesis Research	MV-4460 (4-0) Management of M&S Development ⁵	NW-3285 (3-0) National Security Decision Making	OA-4658 (2-0) Survey of Combat Models ⁶

Key: Computer Science Core Requirements --- MOVES Core Requirements ---
OR Core Requirements --- Refresher Courses --- JPME Requirements --- SIWC Requirements

Block requirements are filled in by choosing THREE blocks from the list.

5. MV4460 will be offered only once per year. Spring entrants take MV4460 in Q6.
6. Concurrently with OA4658, students will also register for and take the MV4924 seminar

MOVES (399) ACCELERATED DEGREE PROGRAM

Quarter 1 (Fall)	CS-3502 (4-2) Computer Comms & Networks	OS-3307 (4-0) Stochastic Models & Military Applications ^{1,4}	OA-3401 (3-1) Human Factors in System Design ¹	MV-4910 (4-0) Research in MOVES ⁵	MV-4921 (2-0) Introduction to MOVES [†]
Quarter 2 (Winter)	MV-3202 (3-2) Computer Graphics Programming	CS-3310 (4-1) Artificial Intelligence	OA-3302 (4-0) System Simulation I	OA/MV4655 (4-0) Intro to Combat Modeling	MV-4922 (2-0) Introduction to Virtual Environment Technology [†]
Quarter 3 (Spring)	Block Requirement	Block Requirement	Block Requirement	MV-0810 Thesis Research	OA-4658 (2-0) Survey of Combat Models ⁴
Quarter 4 (Summer)	MV-4002 (4-1) Simulation and Training ²	MV-4460 (4-0) Management of M&S Development ³	Block Requirement	MV-0810 Thesis Research	OA-4658 (2-0) Survey of Combat Models ⁴

Key: Computer Science Core Requirements --- MOVES Core Requirements ---
OR Core Requirements --- Refresher Courses --- JPME Requirements --- SIWC Requirements

Entry Requirements: Any student wishing to enter the MOVES program under this plan must have a background in computer programming (Java or C++), Probability, Statistics, and Data Analysis (see on-line resources).

† Spring entrants will take MV4923 (Q1), MV4924 (Q2), MV4921 (Q3), MV4922 (Q4). For Spring entrants, Refresher is in Winter, Q1 in Spring, etc.

‡ Students will select ONE concentration block from the list. Any remaining courses will be electives selected with the assistance of the thesis advisor.

Notes:

1. Denotes shared with Human Systems Integration curriculum.
2. Formerly, MV4002 Training in Virtual Environments
3. MV4460 will be offered only once per year. Spring entrants will either take an elective in Q4 and/or can take MV4460 as an overload in Q2.
4. Concurrently with OA4658, students will also register for and take the MV4924 seminar
5. Given the brevity of this program, students must select a concentration block and thesis in Q1. The purpose of this independent study is to prepare the student for the thesis process.

MOVES ON-LINE RESOURCES ENTRY TO ACCELERATED DEGREE PROGRAM

CSR-101 (2-1) Refresher for Lab Systems	MA-1042 (2-0) Matrix Algebra MA1042	MA-1113 (5-2) Single Variable Calculus MA1117 18.01/18.02	MA-1025 (4-0) Intro to Finite Math
CS-2900 CS-3901 CS3771 Programming Practices CS2973 CS2971 C++ for Non-C-Programmers 6.001/6.030	CS-3010 (4-2) Computer Systems Principles CS3030 6.004	OS-3111 OS-3112 OS-3113 Probability, Statistics, & Data Analysis 18.05 18.467	OA-3401 (3-1) Human Factors in System Design
	MV-3204 (3-2) Computer Graphics Modeling Using X3D/VRML MV4204		MV-4002 (4-1) Simulation and Training ⁴
	CS-3502 (4-2) Computer Comms & Networks CS3502 Networking Foundations		OS-3307 (4-0) Stochastic Models & Military Applications
MV-3202 (3-2) Computer Graphics Programming MV4202 6.837	CS-3310 (4-1) Artificial Intelligence	OA-3302 (4-0) System Simulation I	OA/MV4655 (4-0) Intro to Combat Modeling OA/MV4655

Key: **NPS On-line**, see <http://nps.blackboard.com>
Navy e-Learning, see <http://www.navylearning.com>
MIT On-line, see <http://mit.edu/is/courseweb/courses.html>
 Blue designates prerequisite courses for the core requirements in Gray
 Gray designates the two core requirements for an accelerated MOVES degree
 Green designates additional courses that can be taken on-line to further accelerate the degree program

For potential students interested in shortening their residency at NPS, we offer the above matrix of 1st year courses and acceptable on-line equivalents. In order of preference, NPS on-line courses are the closest match and thus are the preferred substitute, next is Navy eLearning courseware, and finally MIT on-line courses (see web addresses above). By completing these courses, a student can reduce their residency requirement to 12 months (four quarters). But this is only valid if all prerequisites are met. For any courses completed via the web, these can be validated when a student arrives on campus, also shortening their residency requirement accordingly.

SELECT THREE BLOCKS

[When selecting a block, ALL courses in the block must be taken]

BL1. Combat Modeling

Coordinator: S. MANAGO

OA4655 Introduction to Combat Modeling (core)

OA4656 Advanced Combat Models

OA4604 Wargaming

OA4602 Joint Campaign Analysis

BL2. Networked Visual Simulation

Coordinator: J. SULLIVAN

MV3202 Computer Graphics Programming (core)

MV3500 Inter-network Communication for Simulation

MV4470 Image Synthesis

MV4471 Computer Animation

BL3. Web-Based Simulation

Coordinator: D. BRUTZMAN

MV3204 Computer Graphics Modeling Using X3D/VRML (core)

MV4205 Advanced Computer Graphics Modeling

MV3250 Introduction to XML Programming

MV4250 Advanced XML Design

BL4. Agents & Cognitive Modeling

Coordinator: J. HILES

CS3310 Artificial Intelligence (core)

MV4015 Agent-Based Autonomous Behavior

MV4025 Cognitive and Behavioral Models for Simulations

MV4100 Cognitive Engineering

BL5. Training Systems

Coordinator: R. DARKEN

MV4002 Simulation and Training (core)

OA4403 Team Performance and Decision Making

OA4402 Skilled Operator Performance

MN4115 Training Foundations & Management

BL6. Human Factors

Coordinator: N. MILLER

OA3401 Human Factors in System Design (core)

MV4001 Human Factors of Virtual Environments

OA3402 Human Performance Measurement

OA4401 Sensation, Perception, and Cognition

BL7. Physically Based Modeling

Coordinator: C. DARKEN

MV3472 Introduction to Physically Based Modeling

MV4472 Physics for Game Developers and Virtual Environments

MV4471 Computer Animation

BL8. Optimization

Coordinator: K. Wood

OA3201 Linear Programming

OA4201 Nonlinear Programming

OA4202 Networks

BL9. Management & Acquisition[†]

MN3331 Principles of Systems Acquisition and Program Management

MN3121

Pick one from:

MN4602 Test and Evaluation Management

MN3309 Acquisition of Weapon Systems Software

MN3384 Principles of Acquisition Production and Quality Management

MN4310 Logistics Engineering

MN3371 Contracts Management and Administration

MN3155 Financial Management for Acquisition Managers

SIWCC (Required for Navy)

CC3000 Introduction to JC4I Systems in DoD

IW3101 Principles of Information Operations

SS3011 Space Technology and Applications

NW3230 Strategy and Policy

JPME (Required for Navy URL)

NW3230 Strategy and Policy

NW3275 Joint Maritime Operations, Part 1

NW3276 Joint Maritime Operations, Part 2

NW3285 National Security Decision Making

Electives

MV4203 Interactive Computation Systems

MV3460 Principles of Software Development

MV4000 Hamming: Learning to Learn

MV4030 Modeling and Simulation of Ocean Environments

[†] Students can only choose BL9 if they are not required to do SIWC or JPME

MV4474 Networked Virtual Environments
OS3040 Research Methods, Planning, & Execution
OA4001 Human Anthropometric Modeling
OA4333 Simulation Methodology
OS3211 Introduction to Optimization (PD21)
MN4119 Manpower Requirements Determination
MN4112 Personnel and Testing
MN4106 Manpower Policy Analysis
Any course from a non-chosen block may be used as an elective

Seminars (required)

MV4921 Introduction to Modeling, Virtual Environments, & Simulation (2-0)
This is a survey of the field of Modeling, Virtual Environments, and Simulation.

MV4922 Introduction to Virtual Environment Technology (2-0)

Replacement for MV4473 in seminar form.

MV4923 Current Research in MOVES (2-0)

Professors brief their area of specialization with focus on thesis projects. *Thesis proposal is due at the end of the quarter.*

MV4924 Research Seminar in MOVES (2-0)

Small group discussions. Thesis students in Q6 will brief thesis plans to their respective small group. Thesis students in Q8 will brief thesis results in small group.

OA4658 Survey of Combat Models

New required seminar for all MOVES students in Q7-Q8.